Phosphate Mining Area Risk Evaluation
Conceptual Notes

I. Problem Statement

The phosphate mining process can result in a shift in the distribution of naturally occurring substances present in surface and subsurface soils, surface water, sediment, and other media. This shift could result in increased risks to human health and the environment. All parties involved desire to understand the magnitude of this risk change. Depending on the magnitude of the risk change, various risk management practices may be used to control those risks. These may include changes in planned remediation / restoration activities, planned land use changes, or restrictions in land use, as well as other alternatives. The purpose of this document is to propose a conceptual basis for characterizing phosphate mining areas and assessing the risk.

II. Risk Assessment Factors

In order to assess the magnitude of this risk the factors influencing the risk level must be quantified. Risk is a function of 1) contaminant concentration, 2) a set of exposure factors which impact the quantity of contaminant ingested, absorbed, or inhaled, and 3) a toxicity factor:

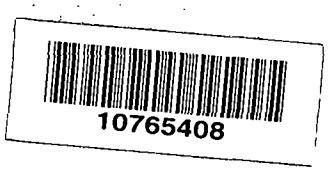
RISK = Concentration X Exposure Factors X Toxicity

A. Concentration

Contaminant concentration can be highly variable. For risk purposes there must be an adequate amount of data to determine the distribution type (normal, log-normal, non-parametric) and then from this the 95% UCL is calculated. The UCL is a function of the variability (standard deviation) mean and number of values. In general, a minimum of 10 samples is necessary for statistical evaluation though 20-30 is preferred. As the area under study increases so does the potential for encountering new pockets of natural but different contaminant levels. For this reason, the number of samples should have a minimum number and also be a function of the area being evaluated.

B. Exposure Factors

Exposure factors include such elements as ingestion / inhalation rate, exposure frequency and duration, body weight, etc. Since these are typically related to the receptor selected (adult resident, child resident, industrial worker, groundskeeper, hunter / fisher, etc.) establishing receptor groups with similar exposure factor may be of value in clearing a land area for use. The potential future uses for any given site could be highly variable, with one area for residential, another portion for recreational, and another for some agricultural purpose. Residential and industrial scenarios / receptors are common comparison points. Others are evaluated on a case-by-case basis. For the phosphate mining operations the following scenarios are proposed:



1) Residential – adult and child

2) Industrial – including standard industrial worker, grounds keeper, area management personnel, etc.

3) Agricultural – Farming. This use would include various types of farming operations to include citrus orchards, truck crops, etc.

4) Agricultural – Ranching. This use would include various cattle ranching operations including beef and dairy cattle. It was separated from farming because for a given contaminant the uptake / retention factors in beef or milk can be substantially different that these factors for plants.

5) Recreational use – High exposure - These would be persons who might have high exposures due to a combination of high contact and high frequency activities. Avid or subsistence hunters / fishers could fall in this category.

6) Recreational use – Low exposure – These are persons with minimal exposures due to low contact nature of the activity or infrequent use. This might include people involved in limited season hunting or hiking activities whose duration is short and activities may not involve intimate contact with soils or other media.

C. Toxicity Factors

Toxicity factors are developed from available research studies. Toxic effects can include both carcinogenic and non-carcinogenic effects. In the case of phosphate operations it is believed that the primary contaminants of concern will be toxic metals and various radionuclides. The mining process has the potential to produce technologically enhanced metal and radionuclide levels from naturally occurring metals and radioactive substances. The risk determination must evaluate both the non-cancer and cancer effects of metals and radioactive materials.

III. Other factors impacting characterization

Phosphate mining operations can cover substantial surface areas. The area is so large that full characterization at the level typical of that done under a RCRA facility investigation or CERCLA superfund RI/FS may not be technically or financially practicable.

The areas potentially requiring evaluation include: a) active mines which may revert to other uses in the future, b) closed mines with limited current uses but with plans for expanded future use, and c) closed mines with a wide variety of current uses including all those noted above (residential, industrial, area management, citrus farming and high

and low exposure recreational use), and d) areas not currently mined which are proposed for mining in the future.

Since the phosphate mining process is primarily a redistribution and potential enhancement of naturally occurring metals and minerals, establishing background levels is critical to the evaluation. A complete background study should be included in the process. It should ideally assess the surface and subsurface soils at various depths to understand the original constituent levels at each depth. In addition to soils, groundwater, surface water, and sediments should be characterized.

The characterization / risk assessment process must consider these factors in the data collection and data evaluation phase of the project. A standardized protocol for data collection linked to the size of the area to be evaluated and to future land use will help to ensure consistency in the process. Once adequate data has been collected, standard EPA risk assessment processes (e.g. RAGS) should be followed.

It is recommended that a set of screening values similar to the EPA Region 9 PRGs be calculated to use in initial data screening. Values should be developed for the standard set of anticipated COPCs including metals and radionuclides. The format should follow the PRG style – showing the concentration associated with both 10-6 cancer risk and non-cancer HQ risk of 1.0. It is likely that this screening will result in clearance of certain areas with no further study. If exceedences of these screening levels are identified then either additional characterization can be performed, the planned use changed, or the area isolated from future land use by some restrictive covenant mechanism.

IV. Ecological Risk

The discussion above focuses on human health risk. In addition a screening process for evaluating ecological risk should be included. The ecological screening values (ESVs) used for performing SLERA (screening level ecological risk assessment) under CERCLA may be appropriate. Since in many cases Florida wetlands have unique habitat characteristics and highly adapted / specialized flora and fauna, proper problem formulation will be critical on a site by site basis. It is believed that the sampling protocol below will result in an adequate number of samples for both human and ecological evaluations.

V. Proposed Process

The proposed characterization / risk assessment process is described below and summarized in Figure 1 attached. The process uses the data presented in Table 1 as the basis for selecting sample size.

Basic Steps:

1. Using a site map, mark the areas with regards to planned future use. All areas should be identified into one of the six (6) uses listed in Table 1. (NOTE: Any areas which have not been involved in mining operations should also be identified for background study.)
2. For each of the contiguous areas determine the area in acres.
3. Using Table 2 which combines the area and use data, determine the number of samples required for characterization
4. Divide each parcel of land into the grid size indicated on Table 2 and number each grid.
5. Using a random number generator, identify random grid numbers to be characterized up to the number of samples specified in Step 3 from Table 2.
6. Obtain samples from each of the grid centers for the analytes of interest (TAL metals, Radionuclides, Organics – VOCs, SVOCs only if industrial operation records indicate this is necessary for the area in question.) All samples must be analyzed using EPA approved methods (SW846) and have QLs (quantitation limits) consistent with the values in the generic screening criteria for the intended use.
7. The site data set would be evaluated as follows:
    a. Comparison to background levels for respective media (surface soil, subsurface soil, sediment, surface water, groundwater)
    b. Comparison to generic risk based screening levels for intended use.
    c. Any analyte exceeding both background and the risk based screening level would be identified as a COPC (contaminant of potential concern)
    d. In addition to this "hot measure" test the site data would also be evaluated to determine if the site data set and background data set came from the same population (WRS, Gehan, etc)
    e. For all analytes which failed either test then a site specific risk assessment would be conducted using the factors outlined in Table 1 and current EPA toxicity factors.
8. Options:
    a. If pass generic screening values for all samples in an area then cleared for that use.
    b. If isolated exceedences – restrict access to those area and clear remainder of area.
    c. If passes site specific risk assessment then cleared for that designated use.
    d. If fails site specific risk assessment then consider other uses, hot spot isolation, remediation, or other actions.

Phosphate Mining Area Characterization & Risk Assessment Protocol _ DRAFT VERSION

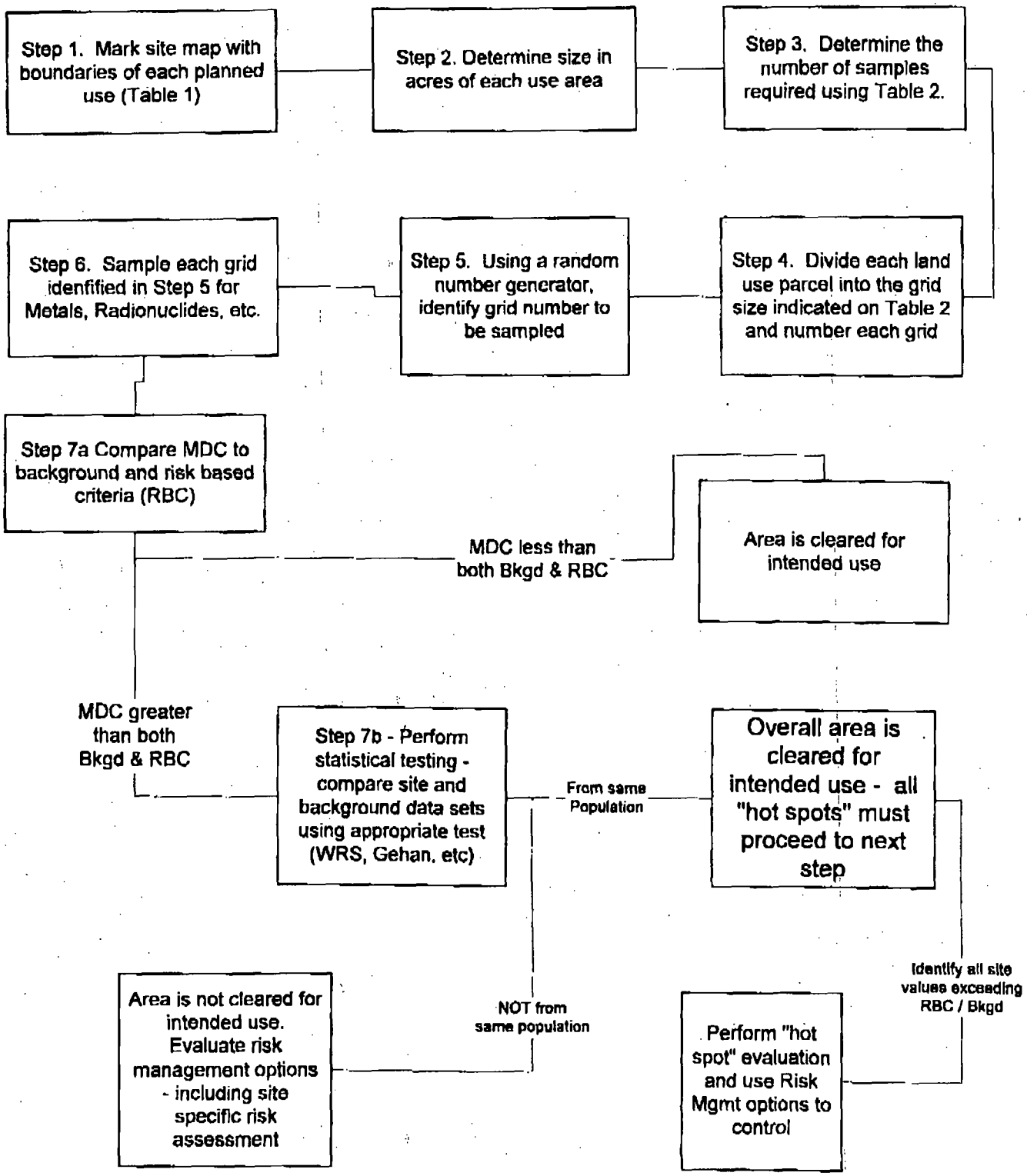


Table 1. Receptor Exposure Scenarios

Receptor Name	Units	Residential Adult	Residential - Child, age 1-6	Industrial Worker	Agriculture - Farming	Agriculture - Ranching	Recreational - High Use	Recreational - Low Use
Exposure Period Factors								
Exposure Time	Hours/day	24	24	8	8	8	8	2
Exposure Frequency	Days/year	350	350	250	104	104	104	26
Exposure Duration	Years	30	6	25	25	25	40	40
Total Exposure	Hours	252000	50400	50000	20800	20800	33280	2080
Ratio to Adult Res.		1.0000	0.2000	0.1984	0.0825	0.0825	0.1321	0.0083
Ration to Rec - Low		121.15	24.23	24.04	10.00	10.00	16.00	1.00
Risk / Toxicity Factors								
Target cancer risk		1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06
Target Hazard Quotient		1.0	1.0	1.0	1.0	1.0	1.0	1.0
Exposure Condition Factors								
Body weight, adult (kg)	kg	70	15	70	70	70	70	70
Default skin surface area for soil contact	cm^2/day	5700	2800	3300	3300	3300	3300	3300
Default adherence factor	mg/cm^2	0.07	0.20	0.20	0.20	0.20	0.20	0.07
Dermal absorption in soil (non-volatile organics)		0.10	0.10	0.10	0.10	0.10	0.10	0.10
Averaging time (years of life):	Years	70	70	70	70	70	70	70
Air breathed (m3/d)		20	10	20	20	20	20	20
Drinking water ingestion (L/d)		2	2	1	1	1	0	0
Volatilization factor - water (L/m^3)		0.5	0.5	0.5	0.5	0.5	0.5	0.5
Volatilization factor - soil (m^3/kg)		chem.spec.	chem.spec.	chem.spec	chem.spec.	chem.spec.	chem.spec.	chem.spec.
Particulate emission factor (m^3/kg)		1.3E+09	1.3E+09	1.3E+09	1.3E+09	1.3E+09	1.3E+09	1.3E+09
Soil ingestion - (mg/d)		100	200	50	50	50	200	100
Residential Age-adjusted factors for carcinogens only								
Ingestion factor for soils ([mg*yr]/[kg*d]) See text.								
Skin contact factor for soils ([mg*yr]/[kg*d]) See text.								
Inhalation factor ([m^3*yr]/[kg-d]) See text.								
Ingestion factor for water ([L*yr]/[kg-d]) See text								

Table 2a. Sampling Rate Data Table (based on EF only)

Scenario			Residential Adult	Residential - Child, age 1-6	Industrial Worker	Agriculture - Farming	Agriculture - Ranching	Recreational - High Use	Recreational - Low Use
Abbr.			RA	RC	0	0	0	0	0
Sampling Ratio -Use:RA			1.0000	1.0000	0.1984	0.0825	0.0825	0.1321	0.0083

Parcel Area	Grid Size (ac)	No. of Grids	N	N	N	N	N	N	N
1	0.1	10	10	10	12	11	11	11	10
10	1	10	11	11	12	11	11	11	10
25	1	25	13	13	12	11	11	12	10
40	1	40	14	14	13	11	11	12	10
50	1	50	15	15	13	11	11	12	10
75	1	75	18	18	13	11	11	12	10
100	1	100	20	20	14	12	12	13	10
160	1	160	26	26	15	12	12	13	10
200	1	200	30	30	16	12	12	14	10
300	1	300	40	40	18	13	13	15	10
400	5	80	50	50	20	14	14	17	10
500	5	100	60	60	22	15	15	18	10
640	**5**	**128**	**74**	**74**	**25**	**16**	**16**	**20**	11
750	5	150	85	85	27	17	17	21	11
1000	5	200	110	110	32	19	19	25	11
1280	5	256	138	138	37	21	21	28	11
1500	5	300	160	160	42	23	23	31	11
2000	5	400	210	210	52	27	27	38	12
3000	5	600	310	310	72	36	36	51	13
4000	5	800	410	410	91	44	44	64	13
5000	5	1000	510	510	111	52	52	77	14
7500	5	1500	760	760	161	73	73	110	16
10000	5	2000	1010	1010	210	93	93	143	18

Table 2b. Sampling Rate Data Table (based on combination of EF & Stats)

Scenario			Residential Adult	Residential - Child, age 1-6	Industrial Worker	Agriculture - Farming	Agriculture - Ranching	Recreational - High Use	Recreational - Low Use
Abbr.			RA	RC	0	0	0	0	0
Sampling Ratio -Use:RA			1.0000	1.0000	0.1984	0.0825	0.0825	0.1321	0.0083

Parcel Area	Grid Size (ac)	No. of Grids	N	N	N	N	N	N	N
1	0.1	10	10	10	12	11	11	11	10
10	1	10	11	11	12	11	11	11	10
25	1	25	13	13	12	11	11	12	10
40	1	40	14	14	13	11	11	12	10
50	1	50	15	15	13	11	11	12	10
75	1	75	18	18	13	11	11	12	10
100	1	100	20	20	20	20	20	20	20
160	1	160	26	26	20	20	20	20	20
200	1	200	30	30	20	20	20	20	20
300	1	300	40	40	20	20	20	20	20
400	5	80	50	50	20	20	20	20	20
500	5	100	60	60	22	20	20	20	20
640	**5**	**128**	**74**	**74**	**25**	20	20	20	20
750	5	150	85	85	27	20	20	20	20
1000	5	200	110	110	32	30	30	30	30
1280	5	256	138	138	37	30	30	30	30
1500	5	300	160	160	42	30	30	31	30
2000	5	400	210	210	52	30	30	38	30
3000	5	600	310	310	72	36	36	51	30
4000	5	800	410	410	91	44	44	64	30
5000	5	1000	510	510	111	52	52	77	30
7500	5	1500	760	760	161	73	73	110	30
10000	5	2000	1010	1010	210	93	93	143	30